Staton, W.M.
1947

A study of certain factors associated with individual and team performance in collegiate basketball.

BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Thesis

A STUDY OF CERTAIN FACTORS ASSOCIATED WITH INDIVIDUAL AND TEAM PERFORMANCE IN COLLEGIATE BASKETBALL

Submitted by

Wesley Morgan Staton
(B.S., University of Alabama, 1942)

In Partial Fulfillment

of the Requirements for the Degree

Master of Education

1947

First Reader: Dr. Leslie W. Irwin, Assoc. Prof. of Health and Physical Education

Second Reader: Dr. John M. Harmon, Prof. of Education

Third Reader: Dr. G. Lawrence Rarick, Assoc. Prof. of Education

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Basketball coaches and students of the game today hold many and varied opinions as to offensive and defensive strategy, ball possession, player fatigue, and methods of shooting free throws. These opinions or theories are, in actuality, unproven hypotheses which are founded primarily on subjective judgement and preference rather than scientific fact.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study (1) to show the relationship, if any, of ball possession to winning team performance; (2) to determine the effect of bad passes upon ball possession and winning team performance; (3) to indicate, by statistical handling of the data, which of the three fundamental free throw methods was most efficient; (4) to show the effect of continuous performance upon free throw accuracy of individual players; and (5) to calculate from the data of this study the normal scoring expectancy of shots taken from various zones or areas of the playing court.

Justification for the study. With the ever-increasing popularity of basketball and its concomitant growth as a national major sport, it becomes more evident that certain aspects of method, technique, and strategy might well be reconsidered and revised in the light of objective evaluation. To this date a large part of our knowledge and theory of the game has been of a rather empirical nature. Truly objective research, as revealed by a survey of the literature, has been so limited as to shed little light upon those phases of the game which deal with methods, techniques, and offensive and defensive strategy. Everett S. Dean, Director of Basketball at Stanford University states that "as the game of basketball becomes more and more scientific the coach of this very popular sport should adopt a scientific attitude toward the game."[1] Thus, it is hoped that this study will serve as an aid and guide to the evaluation of certain opinions and concepts of basketball through the application of objective statistical data obtained under actual game conditions. The investigator has made every effort to keep the data as objective as possible in every phase of the study.

II. DEFINITIONS OF TERMS USED

Bad pass. A bad pass was considered to be that instance when a player, in full possession of the ball,

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1 Everett S. Dean, Progressive Basketball (Stanford University: Stanford University Press, 1942), p. 54.

threw the ball at or toward a teammate in such a manner that it was virtually impossible for the intended receiver to catch the ball before it went out of bounds or into the hands of an opposing player.

Ball possession. Ball possession was considered to be that condition which existed when a player, or players of the same team, maintained full and complete control of the ball while holding, dribbling, or passing it.

Normal scoring expectancy. Throughout the discussion of the data of this study, the term "normal scoring expectancy" shall be interpreted as the probable shooting average, or percentage of successful shots, from a particular zone that may be expected with teams similar to those included in the study.

Two-hand overhand shot. This refers to the typical "chest shot" or "push-arch shot" which is thrown with two hands, in an overhand motion, from a point above the waist.

Underhand shot. This term refers to the "free throw" shot which is made with both hands on the ball in an underhand motion from a point at or below the waist.

One-hand overhand shot. This term indicates the more modern West Coast method of shooting with a one-hand push motion from a point at or above the shoulder.

CHAPTER II

REVIEW OF THE LITERATURE

There has been comparatively little published research dealing with the study of basketball methods, techniques, and strategy from an objective standpoint. The major portion of basketball literature has concerned itself with opinions and tenets which have been, for the most part, based upon a rather subjective evaluation of experience or trial and error.

Elbel and Allen[2] have, to this date, contributed the most objective and pertinent information for evaluating individual and team performance at the college level. This study was carried out at the University of Kansas during the seasons of 1938, 1939, and 1940. The results of the investigation included data collected on the University of Kansas varsity team in twenty-five games, and on the opposing team in nineteen games. Thus, a total of forty-four game samplings were obtained. The authors evaluated individual and team efficiency on the basis of offensive and defensive items which were classified as either positive or negative in nature. These items were ranked and weighted numerically in order to compute indices of "offensive playing efficiency", "defensive play-

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2 E. R. Elbel, and Forrest C. Allen, "Evaluating Team and Individual Performance in Basketball," Research Quarterly, XII, 3:538-555, October, 1941.

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2 E. H. Eibel, and Forrest C. Allen, "Evaluating Team and Individual Performance in Basketball," Research Quarterly, XII, 3:529-535, October, 1941.

ing efficiency", and "composite playing efficiency". In this manner the authors were able to rate individual and team performance in terms of an efficiency index. The conclusions indicated that there is much helpful information available in basketball games which is not used; that scoring ability may be offset by fouls and ball-handling errors; and that mistakes are important game factors.

Dean[3] describes a "game free-throw graph" used at Stanford University on which game percentages, in terms of the team, are recorded. Another foul shooting record, termed a "practice free-throw graph", is kept on individuals. These percentages however, are derived from scores made during practice sessions rather than actual game performances. Neither graph considers any comparison of method in foul shooting.

Other investigations of earlier date have been concerned with physiological effects of the game upon the player, the pivot-post play, the center jump, and raising the height of the basket.[4]

Messersmith[5] recently completed a highly objective experiment which measured the distance covered by players during a regular game. This study however, was not directly

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3 Dean, op. cit., pp. 39-41.

4 Forrest C. Allen, Better Basketball (New York: McGraw-Hill Book Company, Inc., 1937), pp. 19-28.

5 L. L. Messersmith, "Study of the Distance Traveled by Basketball Players", Research Quarterly, XV, 1:29-37, March, 1944.

related to methods, techniques, or strategy and is cited here merely as an example of objective research in the game.

As far as can be determined from a survey of the literature, those factors which were evaluated in this investigation had not, in themselves, been the object of previous published study.

CHAPTER III

TECHNIQUES AND PROCEDURES

In this study the experimenter attempted to utilize highly objective tools for recording, measuring, and statistically analyzing the data. An effort was also made to select a group which would be both representative and adequate for the purpose of the research.

I. THE GROUP STUDIED

Description of the group. The study was carried out during the 1946-47 season of intercollegiate varsity basketball at the Boston Garden and the Boston Arena, Boston, Massachusetts. Twenty-eight games were included in the study, thus affording a total sampling of fifty-six team evaluations since data was collected on both teams in all games. Twenty-seven colleges and universities were represented in the data, and a total of 312 individual players included in the investigation. Although eastern teams were predominant in the sampling, schools from practically all sections of the nation appeared over the course of the season lending an intersectional flavor to the group. A breakdown of the group into geographical sections showed nineteen eastern, five mid-western, two southern, and one far-western school represented.

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II. MATERIALS AND METHODS USED

Timing technique. In order to obtain the total ball possession time for each team, two stop watches were used. These watches were identical makes, purchased at the same time, and synchronized before use in the study. Each watch timed to the nearest tenth of a second and recorded time cumulatively. The recorder, whose duty it was to obtain the total ball possession time for each team, held a watch in each hand. When team A was in full possession of the ball the recorder started the watch assigned to team A; when team A lost possession of the ball the recorder stopped team A's watch immediately. Both watches were stopped when the ball was in a neutral state such as being in the air after an attempted field goal, when out of bounds, during time outs, when loose on the court, or at any time when it did not meet the requirements of ball possession as defined in Chapter I. The procedure for timing ball possession of team B followed that described for team A. Notations of ball possession times were made at the end of each half. Team totals were recorded to the nearest full second.

Charting method. The remainder of the total data collected for the study was recorded on a chart designed by the author for this purpose (Figure 1). The game time was arbitrarily divided into eight periods of five minutes

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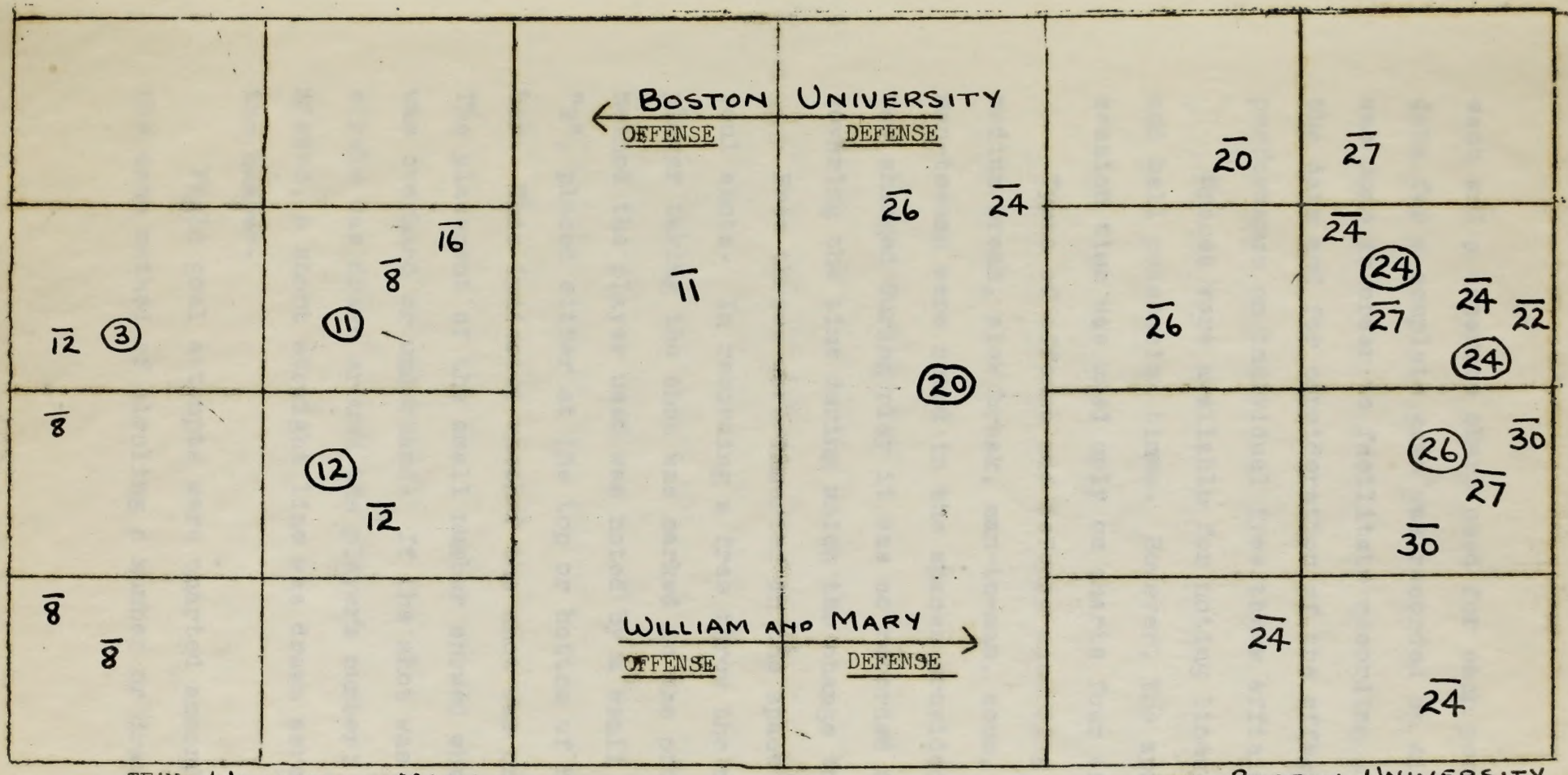
Recording method. The remainder of the total data collected for the study was recorded on a chart designed by the author for this purpose (Figure 1). The game time was arbitrarily divided into eight periods of five minutes



TEAM: WILLIAM AND MARY

NO.	FOR	TIME
30	22	10:45

BALL POSSESSION

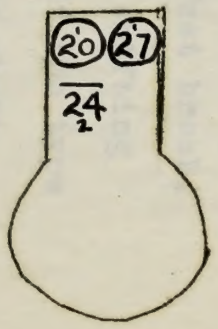
LINEUP

NO.	FOR	TIME

FOULS:

PERIOD 3

FOULS:



TEAM: BOSTON UNIVERSITY

NO.	FOR	TIME
28	16	13:40

NO.	FOR	TIME

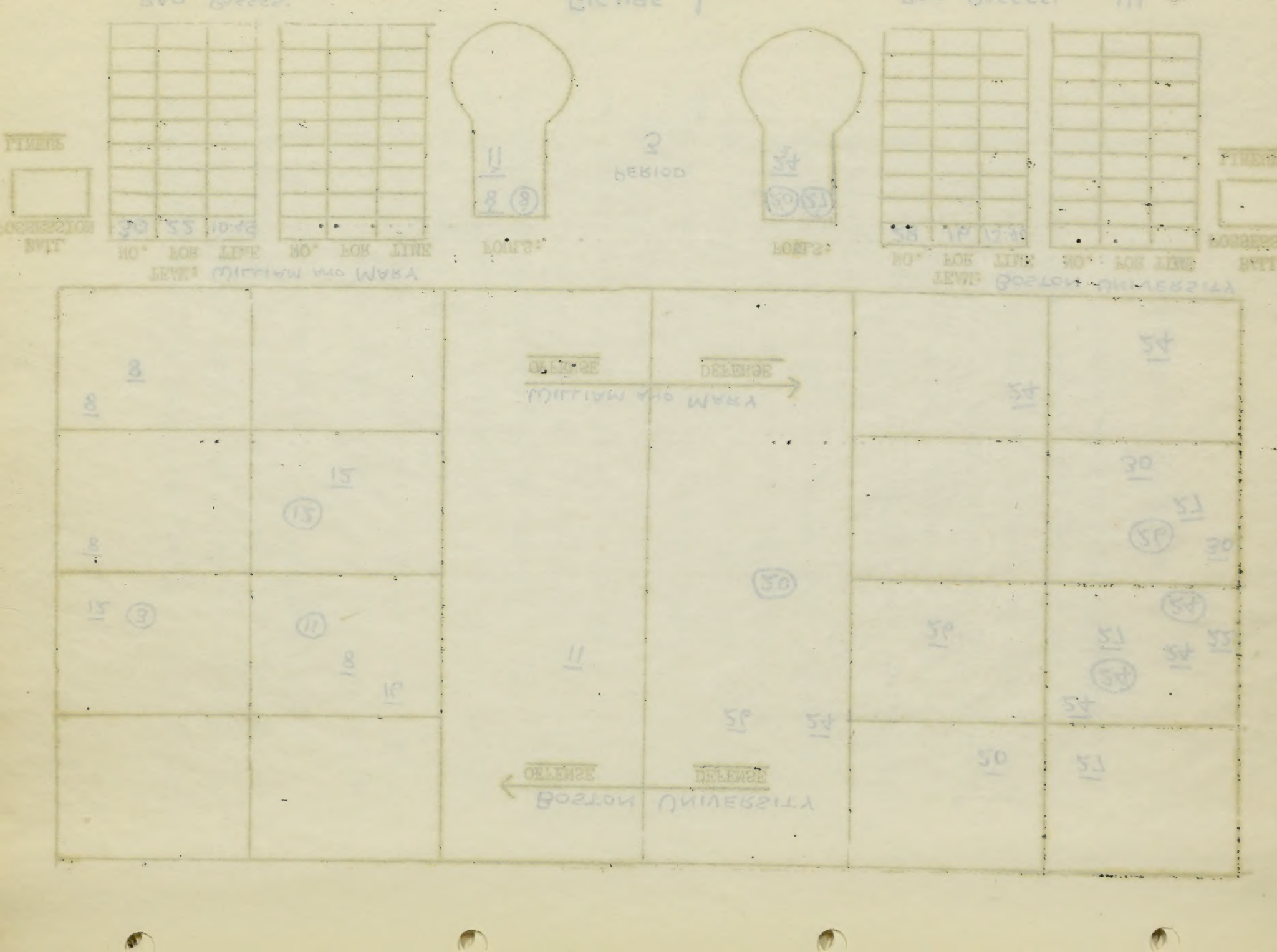
BALL POSSESSION

LINEUP

BAD PASSES:

FIGURE 1

BAD PASSES: 111


OFFENSE
DEFENSE
OFFENSE
DEFENSE

each and a separate chart used for each period. Thus, the data for a complete game was recorded on eight charts; this was done in order to facilitate recording and interpreting the data and for consideration of the effects of continuous performance on individual free throw efficiency.

Spaces were available for noting lineups, substitutions, and ball possession times. However, the space for ball possession time was used only on charts four and eight.

Types of offense and defense according to fast break, medium break, slow break, man-to-man, zone, and shifting man-to-man were noted in the spaces provided. If the type was changed during play it was so recorded on the chart covering the time during which the change took place.

Free throws were inserted in the space set aside for foul shots. In recording a free throw the number of the player taking the shot was marked in the proper space. The method the player used was noted by a small number, "1" or "2", placed either at the top or bottom of his uniform number. This indicated whether the shot was one or two-handed. The placement of the small number showed whether the shot was overhand or underhand. If the shot was successful, a circle was drawn around the player's number; if the shot was missed, a short straight line was drawn across the top of the number.

Field goal attempts were charted according to nine zones; the same method of circling a number or drawing a straight

line directly above the number was used in recording all attempted field goals. The number of the player taking the shot was marked on the chart so as to coincide with his exact position on the playing court, within the limitations of the recorders observation. No attempt was made to note methods used in shooting field goals. The batting of rebounds was recorded as a bona fide attempted field goal.

Bad passes were entered as they occurred at the bottom of the chart, just below the substitution boxes as shown in Figure 1.

Duties of recorders. Two recorders worked at the collection of this data at all games. Observation and recording was carried on in the press box where the investigators were located at each game. One recorder served as ball possession timer while the other charted the data described above. Charting for the entire study was done by one individual so that errors of subjective judgement might be kept constant. The timer often served as an aid and check on the charter in instances of bad passes, rapid successive field goal attempts, numerous simultaneous substitutions, and any other occassion when assistance was required.

CHAPTER IV

DISCUSSION OF DATA

This chapter will be concerned with reporting the findings and results of the study in relation to each of the individual phases of the problem.

I. BALL POSSESSION AND TEAM PERFORMANCE

The relationship of ball possession to team performance. Data on team ball possession was collected on a total of twenty-six games. In terms of total ball possession time, recorded to the nearest second, winning teams showed superiority in seventeen games. Thus, in those seventeen instances, the team that had possession of the ball most won the game. In nine of the contests the losing team maintained possession of the ball for the larger total time. Thus, in nine cases, the team that had possession of the ball for the greater period of time lost the game. However, these figures may be misleading since, in many instances, the winning team used tactics to freeze the ball and deliberately played for possession in order to protect a lead during the latter part of the game.

When ball possession was considered in terms of the half in which a given team scored the most points, this team in turn showed a superiority of possession in twenty-eight instances. On twenty-two occassions the team on the

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When ball possession was considered in terms of the half in which a given team scored the most points, this team in turn showed a superiority of possession in twenty-eight instances. On twenty-two occasions the team on the

short end of the score ranked highest in ball possession time in terms of the half. The apparent discrepancy between the twenty-six games and the fifty separate halves came about as a result of two halves showing equal team scores.

In order to determine statistically the relation of ball possession time to scoring, and concomitant winning performance, the coefficient of correlation was computed on ball possession time, in terms of seconds, and scores, in terms of points. This was based upon the time and point totals of the twenty-six games described above. The result, arrived at by use of the Pearson product moment method, showed a correlation coefficient of +.098. This indicates that possession of the ball in the games studied had very little influence upon scoring. Although the data was limited to a small sampling, it sheds serious doubt upon the current popular belief that ball possession is a decided influence on winning performance.

The effect of bad passes on ball possession and winning performance. Data concerned with the relationship of bad passes to ball possession was obtained from twenty-three games. In three other games the teams showed an equal number of bad passes, and in two games, the opening double-header of the season, ball possession time was not kept on both teams. The data of these twenty-three games studied showed that in fourteen instances the team that

made the largest number of bad passes maintained possession of the ball less time than their opponents. In the remaining nine games the team that made the most bad passes also had possession of the ball most of the time. From these figures it might be indicated that, for the group studied, bad passes had a slightly negative effect upon ball possession.

Study of the relationship of bad passes to winning performance was made on twenty-five games. Three games, in which both teams showed the same number of bad passes, were not included. The data showed that in fourteen games the team that made the most bad passes lost the game. In the remaining eleven games the team that made the most bad passes won the game. On the basis of this data it might be said that, for the group studied, bad passes affected winning performance only to a very small degree.

However, this information concerned with bad passes should be considered in the light of sound judgement and recognition of the fact that the difference in the number of bad passes between teams was relatively minute. To emphasize this point it may be stated here that winning teams averaged 7.6 bad passes per game while losing teams averaged 8.6 per game. Thus, the difference could not be regarded as being highly significant. Unquestionably bad passes have a certain negative effect on team performance inasmuch as loss of the ball in this manner elimi-

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nates a possibility for an attempted field goal.

II. EFFICIENCY OF FREE THROW METHODS

Probably in no other phase of the game do coaches hold such divergent opinion as they do in justifying the use of a "best" method for shooting free throws.

Bunn[6] states that "the two hand underhand, or free throw shot is without doubt the most accurate floor shot." Other outstanding coaches believe the one-hand overhand type to be most accurate, while still another school of thought maintains that the two-hand overhand method gives best results. This portion of the study will present the data gathered on the three basic free throw methods and the efficiency of each under the game conditions studied.

Free throw data in this investigation was considered from two aspects; first, the percentage of shots made by each method was computed, and second, individual raw scores were determined for each of the 146 players in terms of individual percentages: i.e., the ratio of shots made good to shots taken by each individual player. In some cases a man would shoot only once and miss giving him a raw score of 0. On the other hand a player might take one shot and make it, thus obtaining a raw score of 100.

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6 John W. Bunn, Basketball Methods (New York: The Macmillan Company, 1939), p. 136.

Gross percentages by method. The following table shows totals of shots attempted and shots made, with percentages for the three methods.

TABLE I

PERCENTAGE OF SHOTS MADE BY THE VARIOUS FREE THROW METHODS

Method	Attempted	Made	Per cent
Two-hand overhand	245	127	51.8
Underhand	282	158	56.0
One-hand overhand	144	82	56.9

Individual player percentages by method. The following tabulation considers each of the 146 players' percentages in the light of a group of raw scores similar to the results of a test. From this group of scores was determined the mean, the standard deviation, and the standard error for each of the three methods. In addition, critical ratios were calculated for the three types to see if there was any significant difference between these types and to locate the predictive value of any difference which might exist.

The statistical calculations, thus based upon individual raw scores and their group distribution, present a more complete picture of the evaluation and comparison of the three free throw methods.

TABLE II

MEAN, STANDARD DEVIATION, AND STANDARD ERROR OF FREE THROW METHODS BASED ON GROUPED DISTRIBUTION

Method	Players using method	Mean score	Standard deviation	Standard error
Two-hand overhand	53	44.4	32.5	4.5
Underhand	73	53.4	33.6	4.0
One-hand overhand	20	51.0	26.8	6.0

The critical ratios of the various methods were as follows:

Two-hand overhand to underhand..... 1.52

Two-hand overhand to one-hand overhand..... .89

Underhand to one-hand overhand..... .34

On the basis of Sorenson's table, indicating the chances in 1000 in which a true difference would be expected to occur, the following predictive values were assigned:[8]

1.52 ..... 935 in 1000

.89 ..... 813 in 1000

.34 ..... 634 in 1000

Due to the preciseness of the measure (that is, the ease with which one could decide on the type of shot being

8 Herbert Sorenson, Statistics for Students of Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1936), p. 367.

used), the 2.6 per cent level of significance might be logically selected. However, since the groups shooting by the three methods were not equated, the lower level of 1.0 per cent was chosen as indicating statistical significance. Since none of the critical ratios achieved this level of significance, the highest level being that of the two-hand overhand to the underhand type, there appears to be no statistical significance between methods as shown by observed data.

Thus, from the data collected on this group, indications are that the underhand and the one-hand overhand methods might give better results in the long run with a group similar to this.

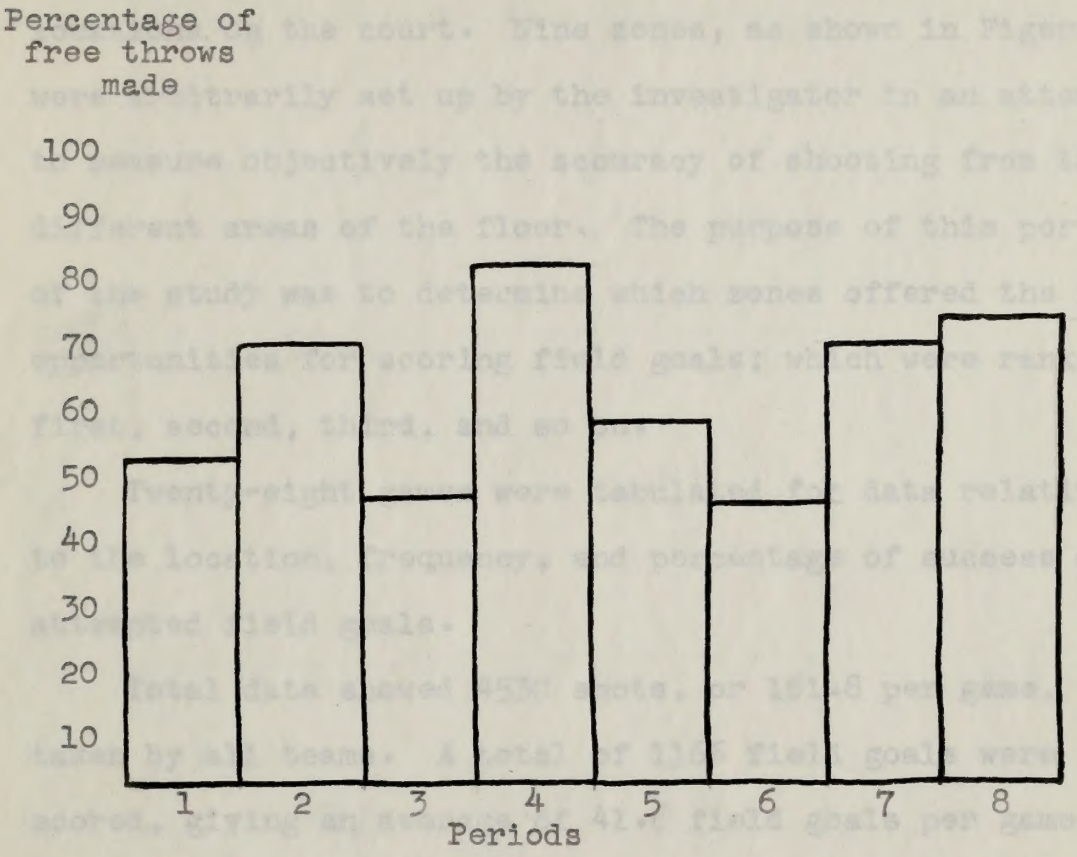
III. THE EFFECT OF CONTINUOUS PERFORMANCE UPON FREE THROW ACCURACY

The element of possible fatigue through continuous performance during a game was studied on twenty-two players who played a full game without substitution. This sampling was, of necessity, limited as a result of the widespread coaching practice of frequent substitution. Each player's free throw record was tabulated according to eight five minute periods, thus giving a fairly objective picture of the relationship of free throw accuracy to continued play throughout the entire contest.

The following bar graph (Figure 2) represents the various levels of foul shooting efficiency of the group at the eight stages of the game.

FIGURE 2

LEVELS OF FREE THROW EFFICIENCY DURING THE VARIOUS PERIODS OF PLAY



Although the data here is insufficient to draw any conclusions on, it is interesting to note the upward trend of accuracy in shooting fouls during each half. This may indicate that a player shoots more efficiently when "warmed up". Further study is indicated on a larger group under game conditions. Again, the sampling will be difficult to enlarge upon as a result of the frequency of substitutions in the college game.

FIGURE 2

LEVELS OF FREE THROW EFFICIENCY DURING THE VARIOUS PERIODS OF PLAY

IV. ZONES AND NORMAL SCORING EXPECTANCY

This phase of the study dealt primarily with the number of field goals attempted and made from the various locations on the court. Nine zones, as shown in Figure 3, were arbitrarily set up by the investigator in an attempt to measure objectively the accuracy of shooting from the different areas of the floor. The purpose of this portion of the study was to determine which zones offered the best opportunities for scoring field goals; which were ranked first, second, third, and so on.

Twenty-eight games were tabulated for data relative to the location, frequency, and percentage of success of attempted field goals.

Total data showed 4530 shots, or 161.8 per game, taken by all teams. A total of 1166 field goals were scored, giving an average of 41.6 field goals per game for both teams together.

The percentage of field goals scored for the entire twenty-eight games was 25.7; this compares favorably with Elbel and Allen's reported average of 25.2 per cent on the University of Kansas squad. Thus, for this group, the normal scoring expectancy was 25.7 per cent. In other words, teams of this type could be expected to score once out of every four attempted field goals.

Winning teams, considered as a group, took a total of

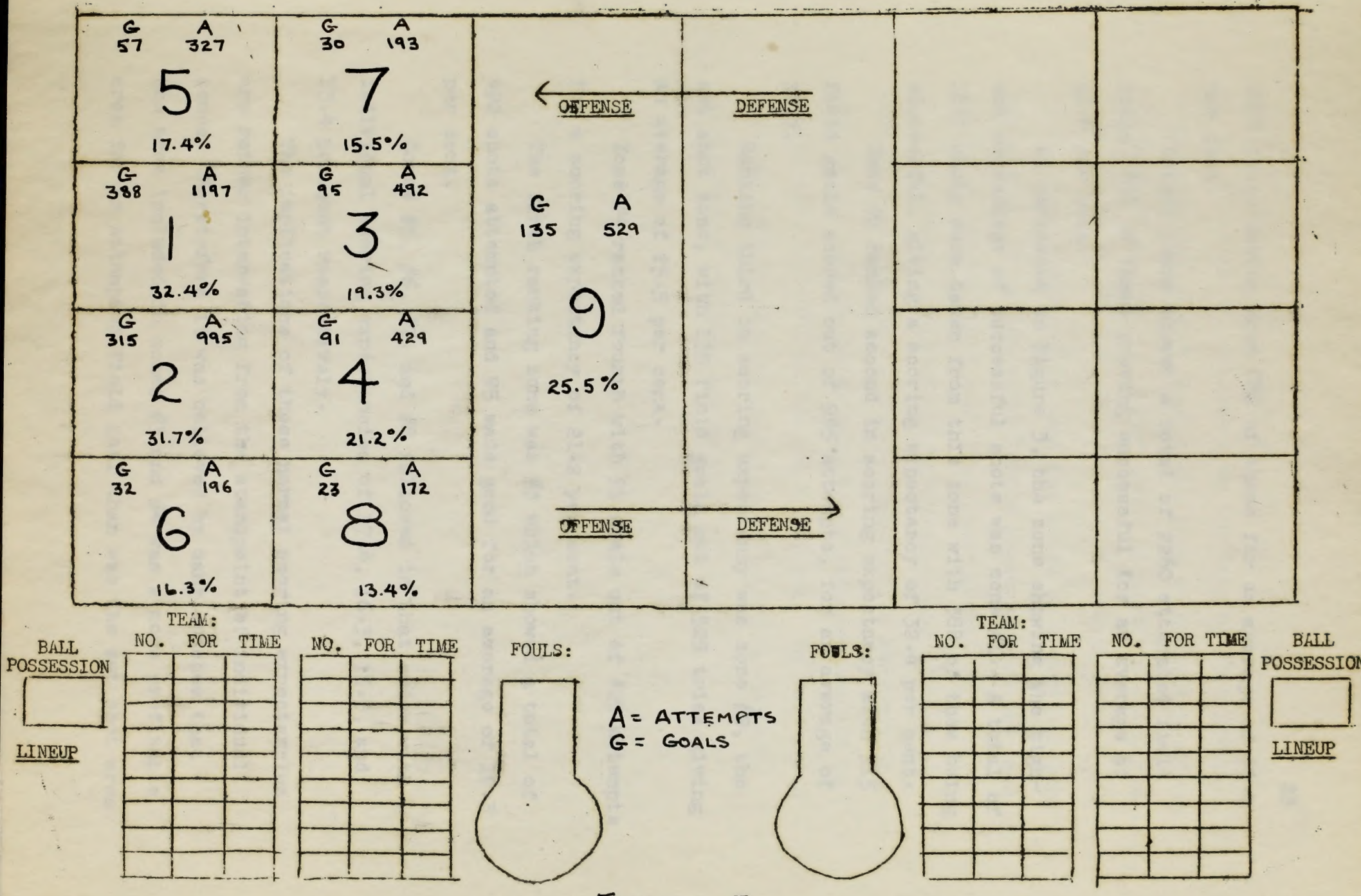

G A
57 327
5
17.4%
G A
30 193
7
15.5%
G A
388 1197
1
32.4%
G A
95 492
3
19.3%
G A
315 995
2
31.7%
G A
91 429
4
21.2%
G A
32 196
6
16.3%
G A
23 172
8
13.4%
G A
135 529
9
25.5%
OFFENSE
DEFENSE
OFFENSE
DEFENSE
TEAM:
NO. FOR TIME
NO. FOR TIME
BALL POSSESSION
LINEUP
FOULS:
A = ATTEMPTS
G = GOALS
FOULS:
TEAM:
NO. FOR TIME
NO. FOR TIME
BALL POSSESSION
LINEUP

FIGURE 3

FIGURE 2

C = GOATS
A = ATTENDANTS

BOERS:

NO. FOR EACH:

BOERS:

NO. FOR EACH:

ENTRANCE

DISPERSION

DISPERSION

ORIENTATION

ORIENTATION

2271 shots making good 682 of these for an average of 30.0 per cent.

Losing teams showed a total of 2260 attempted field goals, 484 of these proving successful for an average of 21.4 per cent.

As indicated in Figure 3, the zone showing the highest percentage of successful shots was zone #1. A total of 1197 shots were taken from this zone with 388 of them being successful, giving a scoring expectancy of 32.4 per cent.

Zone #2 ranked second in scoring expectancy with 315 field goals scored out of 995 attempts, for an average of 31.7.

Ranking third in scoring expectancy was zone #9, the set shot zone, with 135 field goals out of 529 tries giving an average of 25.5 per cent.

Zone #4 ranked fourth with 91 goals out of 429 attempts for a scoring expectancy of 21.2 per cent.

The fifth ranking zone was #3 which showed a total of 492 shots attempted and 95 made good for an average of 19.3 per cent.

Zones #5, #6, #7, and #8 followed in that order with individual scoring expectancies of 17.4, 16.3, 15.5, and 13.4 per cent respectively.

The implications of these normal scoring expectancies are rather interesting from the standpoint of individual zones. Heretofore it was believed by many coaches that the area included in zones #3 and #4 was a more profitable area for an attempted field goal than was the set shot area

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Zones #5, #6, #7, and #3 followed in that order with individual scoring expectancies of 17.4, 16.3, 15.5, and 13.4 per cent respectively.

The implications of these normal scoring expectancies are rather interesting from the standpoint of individual zones. Heretofore it was believed by many coaches that the area included in zones #3 and #4 was a more profitable area for an attempted field goal than was the set shot area

included in zone #9. Zones #1, #2, and #9 would seem to be the zones which, according to the data on this group, would prove to be most profitable from an offensive aspect in these areas. On the other hand, it might be concluded that, since zones #3, #4, #5, #6, #7, and #8 show scoring expectancies considerably less than the total or overall scoring expectancy, it is not worth losing possession of the ball for an attempted field goal from these areas.

The teams considered in this study were of varying abilities and styles of play. Therefore, a representative sampling of college basketball teams might be assumed as having been included in the group studied. In this sense the zone data on scoring expectancies might be regarded as reasonably reliable and valid.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary. In summing up the high points of this study it may be stated that, for the particular group studied, ball possession did not have any significant effect either upon scoring or winning performance. This does not mean that a team could throw bad passes promiscuously throughout the game, nor could they regard ball possession as not effecting performance since this data was obtained upon teams which were playing fundamentally sound basketball. The data does suggest that under the normal game conditions these factors were relatively insignificant.

Free throw data from this group shows no significant difference in any of the three basic methods used. This information, based upon statistical fact, is controversial to opinions held by many coaches today.

Continuous performance, and its probable accompanying fatigue, showed a positive rather than negative effect upon free throw accuracy. Here again, in this rather limited sampling, objective measurement refutes current popular opinion.

Zoning of the court brought out several highly significant indications from the data. Outstanding among these was the surprisingly high scoring expectancy occurring in the set shot zone or area.

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Scoring of the court brought out several highly significant indications from the data. Outstanding among these was the surprisingly high scoring consistency in the set shot zone or area.

Conclusions. Undoubtedly further objective study is indicated from those points and findings of this investigation which obviously are in contrast to general popular opinion and theory.

It may be concluded that accuracy of shooting is, as was previously believed, the keynote of success in winning games. There was relatively little difference in total shots taken by winning teams and losing teams; accuracy proved the deciding factor.

Those free throw methods which proved most efficient in this study, the one-hand overhand and the underhand, might best be utilized by giving consideration to the individual player and/or the particular team style of play. Further study on this phase of the game is needed, possibly with a larger sampling or with a high school group.

In regard to bad passes, it might be said that winning performance is affected only slightly by bad passes. However, this statement must be considered to apply only within reasonable limitations; i.e., frequency of bad passes should not greatly exceed normal bad pass averages as set forth in Chapter IV.

More research is needed to consider the effect of fatigue upon the performance of individuals. This type of study presents many variables which are very difficult to control under normal game conditions.

Probably of most significance, in the eyes of the author, was the data on shooting averages or normal scoring

expectancies in the various zones of the court. Entire systems of offense and defense, within limitations, can be built and planned on the basis of this data. Here too further research is required with special attention to a possible larger sampling. A study carried out in another section of the country is necessary in order to standardize and compare zone scoring expectancies. An investigation might be carried out to consider the various methods or types of shots taken in the different zones.

Coaches, players, and students of the game in all sections of the nation would do well to make application of objective and scientific measurement to the many phases of the game in order to re-evaluate some of the hypotheses upon which the game is founded. Investigation of this nature will do much to improve and foster the game at all educational levels.

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